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1986 GLIMPCE Seismic Reflection Survey

Stacked Data

by

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ABSTRACT

During August and September of 1986, 1370 km of deep crustal marine multichannel seismic reflection data were collected in the Great Lakes region as part of the Great Lakes International Multidisciplinary Program on Crustal Evolution (GLIMPCE). The energy source was a 127.5-liter (7,780 in^3) tuned airgun array, and 20 seconds of data were recorded with a 3 km streamer composed of 120 channels. The primary purpose of the survey was to better understand the deep structure and tectonics of the midcontinental rift system (MRS) and the Grenville tectonic province. The stacked seismic time sections are presented here at a scale of about 1:200000 (5 km/in) yielding no vertical exaggeration for an assumed crustal velocity of 6 km/s.

INTRODUCTION

Multichannel seismic data over the Great Lakes were acquired by Geophoto Services, Ltd., a Canadian subsidiary of Geophysical Services Inc., under contract to the U.S. Geological Survey (USGS) and the Geological Survey of Canada (GSC) as part of the Great Lakes International Multidisciplinary Program on Crustal Evolution (GLIMPCE). Approximately 1370 km of seismic reflection data were acquired during August and September 1986. Shotpoint locations for each line are shown in figure 1. Seismic lines A, B, C, F and G (a total of 655 km) were located in Lake Superior, line H (284 km) in Lake Michigan, and lines I and J (431 km) in Lake Huron. This seismic survey was designed to resolve the deep crustal structure of the Keweenawan Rift (lines A,C,F,G and H), and the Hemlo and Michipicoten Granite/Greenstone Belts (line B), the Grenville Front (line J), the deformed Huronian continental margin (line I) and the Penokean Orogen and Niagara Fault (line H) (Green and others, 1987). Figure 2 is a generalized geologic map of the study area. This report presents a brief summary of the data processing and displays of the stacked seismic data. Other reports give details of the acquisition and processing parameters (Lee and others, 1988) and migration parameters (Milkereit and others, 1988). Preliminary interpretations exist for the deep structure (Behrendt and others, 1988a, 1988b), for the Keweenavan Rift (Cannon and others, 1988) and for the Grenville Front (Green and others, 1988).

DATA PROCESSING AND DISPLAYS

Data from the GLIMPCE seismic reflection lines were acquired using a 3 km long streamer with 120 recording channels spaced at intervals of 25 meters. The seismic energy source was a tuned array of 60 airguns with a total volume of 127.5 liters (7780 in3). Details of the acquisition parameters are given on a line by line basis on the side labels of plates 1-8.

All of the data were stacked and plotted for interpretation at the USGS seismic data processing center in Denver, Colorado. The primary goal of the seismic data processing was to image the deeper part of the sections (>5 seconds). Processing that could enhance the shallow section was not attempted.

Processing was performed on a VAX 11/780 configured with 8 megabytes of memory (RAM), and 2 Floating Point Systems array processors, and DISCO seismic data processing software from COGNISEIS (formerly DIGICON). The processing sequence used is shown in figure 3. To improve the displays of the stacked data, a two-dimensional, smoothing filter and amplitude modulation were used. A 3 trace by 3 time sample, operator was used for the two-dimensional smoothing. To modulate the amplitudes, the input traces were multiplied by their amplitude envelopes raised to the power of 1.2 (Lee and others, 1988). These were especially effective in improving the presentation of deep reflections from 10 to 14 seconds. After completion of the processing, the final unmodulated, stacked data were output to magnetic tape in SEG-Y format and were shipped to the seismic processing center of the Lithosphere and Canadian Shield division of the GSC in Ottawa, Canada for the migration of the data.

To facilitate the handling of the final stacked sections, the data were summed 4 to 1, thus creating a consistent 50 meter common mid-point (CMP) interval for all final displays. The final seismic time sections (plates 1 - 8) are displayed at a horizontal scale of 100 traces per inch, approximately 1:200,000 if an interval velocity of 6 km/sec is assumed.

Results from this phase of the GLIMPCE seismic reflection data processing are presented to complement the results of the frequency-wavenumber (F-K) migrated data released by Milkereit and others (1988) and for use as the basis for independent interpretations and future reprocessing efforts. These data, together with other geological and geophysical data, may allow more accurate interpretation of this complex data set.

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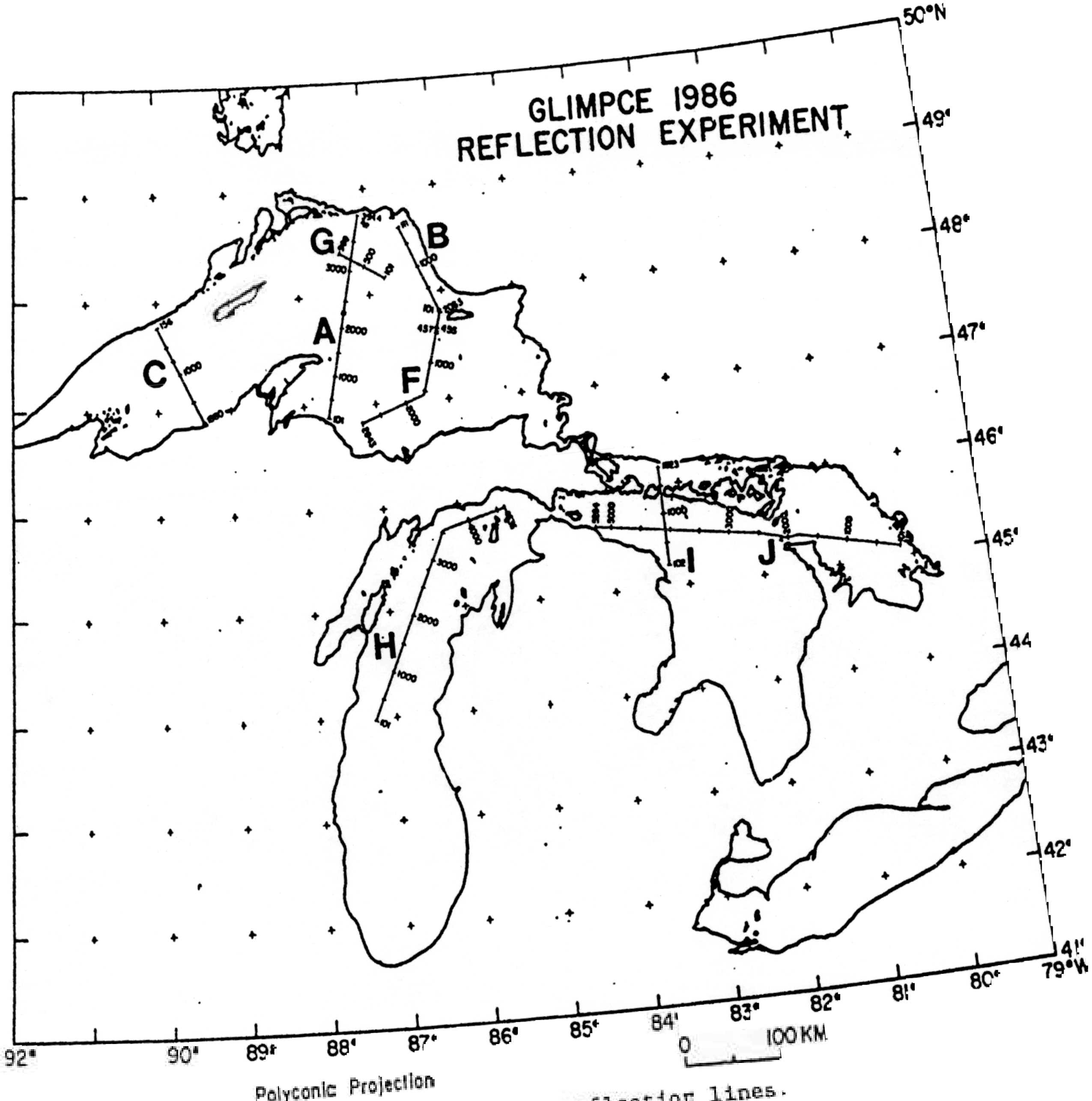

Figure Shotpoint map for GLIMPCE seismic reflection lines.

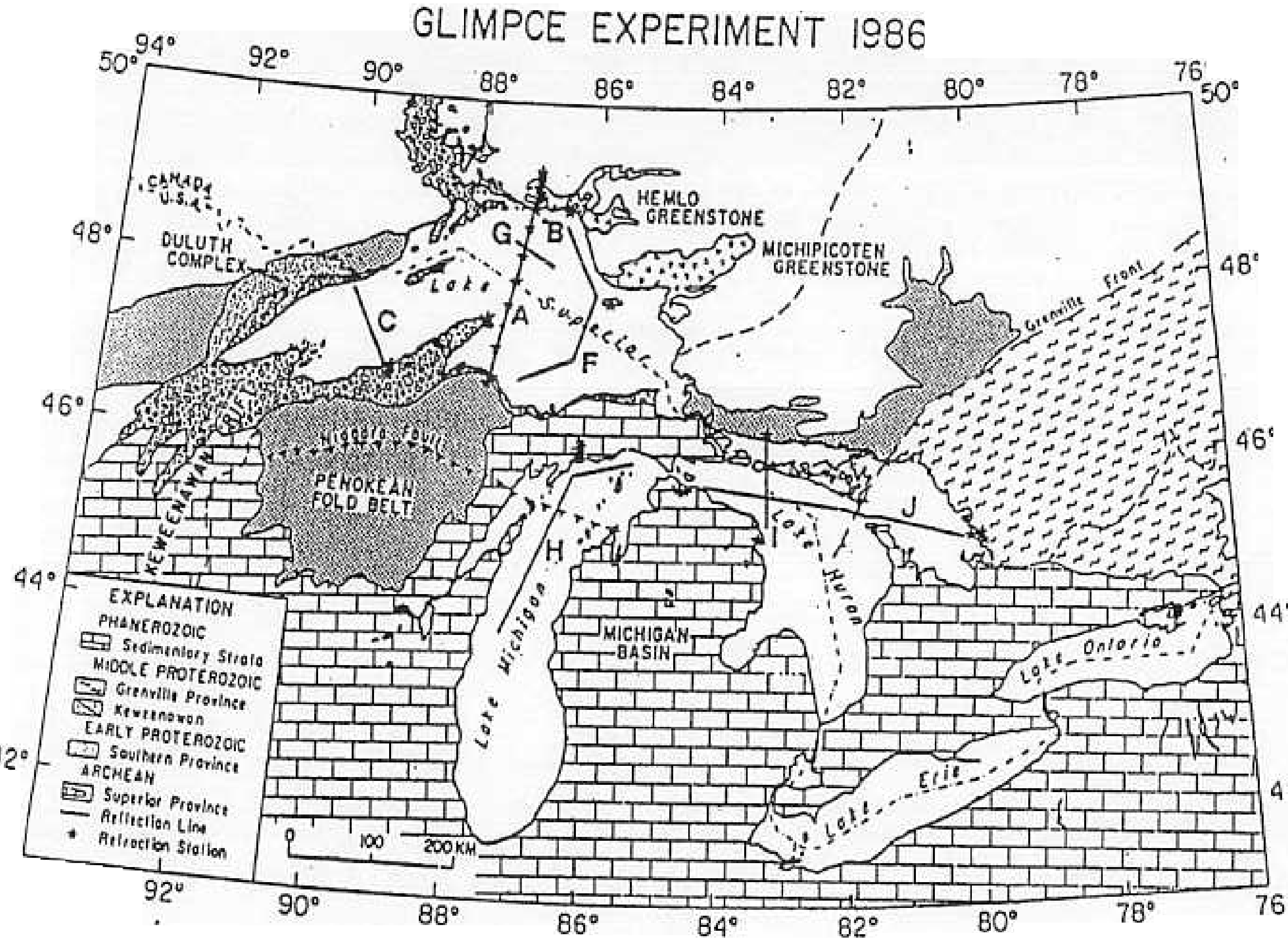

Figure 2.--Location of GLIMPCE seismic reflection lines in relation to geologic features

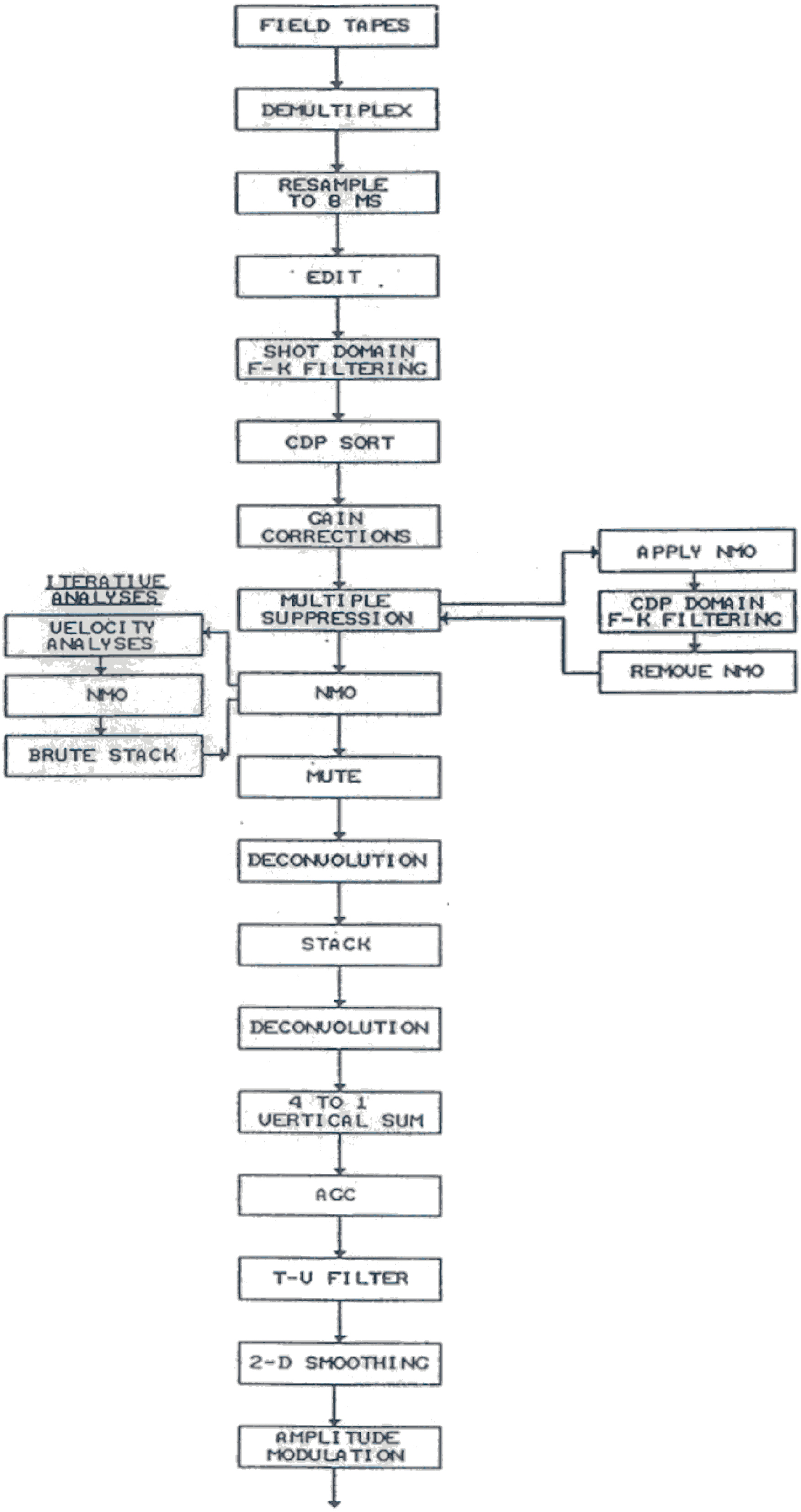

Figure 3.--Data processing sequence for the GLIMPCE seismic reflection data.